CONSTRUCTION SPECIFICATIONS

ASPHALT PROTECTIVE COATINGS FOR PIPE LINES

COMPLIMENTS OF

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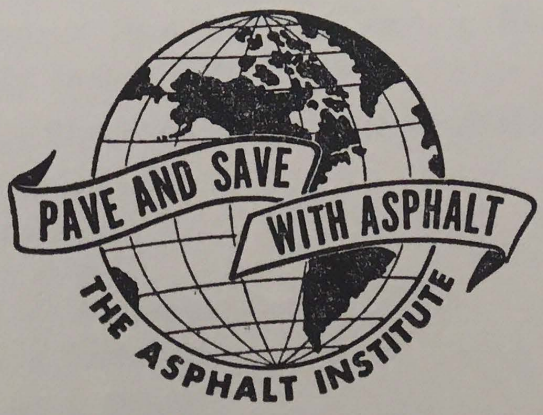
THE ASPHALT INSTITUTE

Asphalt Protective Coatings for Pipe Lines



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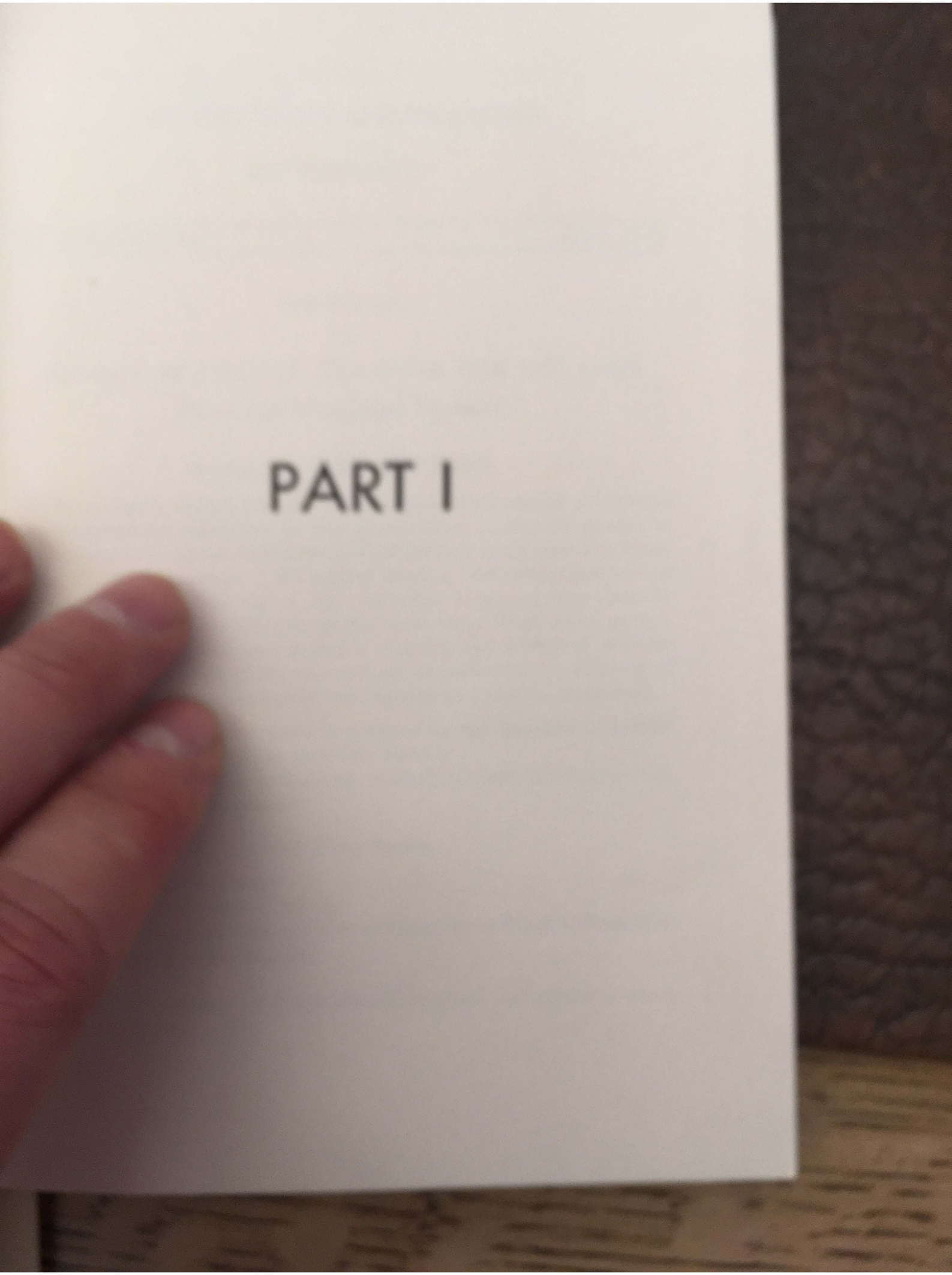
FOREWORD

Under present practice, asphalt protective coatings for pipe lines can be classified into four major types as follows:

DESIGNATION	DESCRIPTION
C-1	Thin Coat Wrapped Systems
C-2	Thick Coat Wrapped Systems
C-3	Mastic Systems
C-4	Coatings for Interior Surfaces

Full recognition has been given to these four types in preparation of four specifications included herein, each one complete in itself. This has necessarily resulted in a certain amount of repetition.

The protective coating system to be used in any given locality should be chosen by the Engineer to fit applicable conditions and special requirements.


PART I

PART I

CONSTRUCTION SPECIFICATIONS

SPECIFICATION C-1

The Asphalt Institute — May, 1954

Specification

for

ASPHALT PROTECTIVE COATINGS FOR PIPE LINES

Thin Coat Wrapped Systems

Section 1—DESCRIPTION

1.1 Thin coat wrapped systems for pipe lines shall consist of a prime coat followed by either one or two applications of asphalt enamel in conjunction with one or more layers of reinforcing and protective wrappings. The final thickness of the asphalt coating, including a primer and the inner wrap, shall be $\frac{3}{32}'' \pm \frac{1}{32}''$. An outer wrap may sometimes be applied in place of or in addition to the inner wrap. When extra protection* is required, additional layers of coating and wrapping shall be applied. When rock fill is encountered, extra protection* consisting of selected backfill or prefabricated rock shields may also be employed.

1.2 The wrapping system shall be selected by the Engineer and shall conform to one of the types specified below:

(a) Where a single wrap is required, it shall be constructed according to the following system:

Single Wrap System

1 coat of Asphalt Primer
1 coat of Hot Asphalt Coating
1 wrap of Asphalt Saturated Felt or Glass Outer Wrap or Glass Mat embedded in the coating.

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* NOTE. The Engineer shall specify the location and extent of extra protection required.

(b) Where a double wrap is required, it shall be constructed according to one of the following systems:

Single Coat—Double Wrap System

1 coat of Primer
1 coat of Hot Asphalt Coating
1 wrap of Glass Mat (embedded in coating)
1 wrap of Asphalt Saturated Felt or Glass Outer Wrap

Double Coat—Double Wrap System

1 coat of Primer
1 coat of Hot Asphalt Coating
1 wrap of Asphalt Saturated Felt or Glass Mat
1 coat of Hot Asphalt Coating
1 wrap of Asphalt Saturated Felt or Glass Outer Wrap

(c) Where more than a double wrap is required, the procedure specified in either of the Double Wrap Systems is modified to permit additional layers of Hot Asphalt Coating and inner wraps of Asphalt Saturated Felt or Glass Mat.

Section 2—MATERIALS

2.1 PRIMER

The primer shall be composed of a petroleum asphalt base and petroleum solvents, suitably blended to produce a liquid coating which may be applied cold by brushing or spraying and which will produce a suitable bond between the metal and the asphalt coating. The primer shall have good spraying, brushing and leveling properties and a minimum tendency to produce bubbles during application. It shall be homogeneous, free from water and shall meet the following requirements:

Bond Strength, 77°F., psi	250+
Flash Point (Open Tag), °F	100+
Furol Viscosity at 77°F., sec	50–150
Distillation:	
Distillate (percent of total distillate to 680°F.),	
To 374°F	35+
To 437°F	75+
To 500°F	87+

(b) Where a double wrap is required, it shall be constructed according to one of the following systems:

Single Coat—Double Wrap System

1 coat of Primer
1 coat of Hot Asphalt Coating
1 wrap of Glass Mat (embedded in coating)
1 wrap of Asphalt Saturated Felt or Glass Outer Wrap

Double Coat—Double Wrap System

1 coat of Primer
1 coat of Hot Asphalt Coating
1 wrap of Asphalt Saturated Felt or Glass Mat
1 coat of Hot Asphalt Coating
1 wrap of Asphalt Saturated Felt or Glass Outer Wrap

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Bond Strength, 77°F., psi	250+
Flash Point (Open Tag), °F	100+
Furol Viscosity at 77°F., sec	50–150
Distillation:	
Distillate (percent of total distillate to 680°F.),	
To 374°F	35+
To 437°F	75+
To 500°F	87+

To 600°F.	
Residue from distillation to 680°F., Volume percent by difference	97+
Tests on Residue from Distillation:	30–45
Penetration at 77°F., 100 g., 5 sec.	2–12
Softening Point (Ring & Ball), °F.	180–260
Percent Soluble in CCl_4	99.0+

2.2 ASPHALT COATING

The asphalt coating shall be composed of petroleum asphalt combined with appropriate inert mineral fillers. It shall be uniform in character, free from water and shall not foam when heated to 400°F. It shall meet the following requirements for the grade selected by the Engineer when tested in accordance with the methods hereinafter enumerated:

	Grade		
	I	II	III
Softening Point (Ring & Ball), °F.	180–210	210–240	240–260
Penetration at 77°F., 100 g., 5 sec.	10–	8–	6–
Penetration at 115°F., 50 g., 5 sec.	35–	30–	25–
Flash Point (Cleveland Open Cup), °F.	450+	450+	450+
Loss on Heating at 325°F., 5 hrs., Percent	0.5–	0.5–	0.5–
Ash, Percent	10–40	5–40	5–40
Settlement (Ratio of ash in bottom half to ash in top half after 5 hrs. at 400°F.), max.	3:1	3:1	3:1
High Temperature Sag:			
24 hrs. at 120°F., inches	1/32–	—	—
24 hrs. at 140°F., inches	—	1/32–	—
24 hrs. at 160°F., inches	—	—	1/32–

This table continued on following page

	Grade		
	I	II	III
Cracking or Disbonding after 5 hrs. at −20°F	None	None	None
Deflection Test (Initial Heating), inches	0.8+	0.8+	0.8+
Disbonded Area, square inches	3.0−	3.0−	3.0−
Deflection Test (After 2 hrs. Heating), inches	0.6+	0.6+	0.6+
Disbonded Area, square inches	5.0−	5.0−	5.0−
Impact at 77°F.:			
Indirect Impact, (Disbonded Area), square inches	2.0−	2.0−	2.0−
Direct Impact, (Disbonded Area), square inches	10.0−	10.0−	10.0−
Peel	No Peeling	No Peeling	No Peeling
Flow Resistance:			
Penetration at 85°F., 100 hrs., inches	0.01−	0.01−	0.01−
Penetration at 115°F., 6 hrs., inches	0.02−	0.02−	0.02−
Electrical Resistance, Salt Water Immersion, 7 days, megohms/sq. ft	1000+	1000+	1000+

2.3 PIPE LINE WRAPPING

The pipe line wrappings shall consist of asphalt saturated rag or asbestos felt and either unsaturated or asphalt saturated bonded fibrous glass mats. Choice of the wrappings will depend upon the Coating System selected by the Engineer.

(a) Asphalt Saturated Rag and Asbestos Pipe Wrapping Felts shall meet the requirements of ASTM D226 for the Rag Felts and ASTM D250 and ASTM D655 for the Asbestos Felts, with the following modifications and additions. Roll widths, lengths and other

packaging details shall be in accordance with agreements between the manufacturer and the purchaser. When used for an inner wrap, neither side of the felt shall be sanded or dusted with mica or any other material that will prevent an adequate bond. Where the felt is to be used for an outer wrap, the outer surface may be dusted. The pipe wrapping felts shall meet the following minimum requirements:

	13 lb. Rag Felt	20 lb. Rag Felt Coated	15 lb. Asbestos Felt	23-½ lb. Asbestos Felt Coated
Weight/100 sq. ft., min.	12.8	20.2	13.6	22.5
Tensile Strength, lbs./lin. in., min.:				
Along Roll	50	50	25	30
Across Roll	20	20	10	15
Pliability at 77°F	Pass	Pass	Pass	Pass
Radius of Bend	½ in.	½ in.	1 in.	¾ in.
Elmendorf Tear, min.:				
Along Roll	200	200	140	140
Across Roll	300	300	160	160

(b) Glass Mat Inner Wrap shall be a thin, uniform, bonded mat, slit into suitable widths and packaged firmly and evenly on tubes as specified by the Engineer. The mat shall be free from large holes, thin spots, delaminations, tuftings, oil and grease, and relatively free from pimples, small holes, uncured binder spots, wrinkles, slugs, dust and torn edges. The ends of the rolls shall be clean, smooth and square cut and shall show no telescoping. The glass mat inner wrap shall conform to the following requirements:

Weight/100 sq. ft., lbs., min.	0.84
Thickness in inches, min.	0.013
Trapezoidal Tear Strength, in.-lbs./in., avg., min.:	
Along Roll	1.0
Across Roll	2.0
Tensile Strength, lbs./lin. in., avg., min.:	
Along Roll	9.0
Across Roll	3.0

Pliability, ⅛ in. radius, 77°F	Pass
Porosity, in. of water at 200 fpm, avg., max	0.06
Ignition Loss, percent, max	2.1
Moisture Absorption, percent, max	1.0

(c) Asphalt Saturated Glass Wrap shall be used for outer wrap only and shall have a smooth or veined appearance, free from visible defects such as large holes, ragged or untrue edges, breaks, cracks, tears, protuberances or indentations. Loose mica or other material used for dusting shall be removed from the surface of the wrap by brushing or other suitable means prior to packaging. Roll widths, lengths and other packaging details shall be in accordance with agreements between the manufacturer and the purchaser. The asphalt saturant and surface material shall be applied uniformly in approximately equal thicknesses on both sides and up to the edges of the wrap. When unrolled at temperatures of 32°F. to 100°F., it shall not stick to such an extent as to cause tearing. The asphalt saturated glass outer wrap shall conform to the following requirements:

Weight/100 sq. ft., lbs., min	9.0
Thickness, in., min	0.030
Tensile Strength, lbs./lin. in., avg., min.	
Along Roll	16.5
Across Roll	8.0
Trapezoidal Tear Strength, in.-lbs./in., avg., min.	
Along Roll	2.0
Across Roll	4.0
Pliability	
1 inch Mandrel at 0°F	Pass
½ inch Mandrel at 32°F	Pass
⅛ inch Mandrel at 77°F	Pass
Saturation—percent by weight of extractable material, min	65.0
Moisture Absorption, percent, max	0.5

2.4 APPROVAL OF MATERIALS

Prior to use, a certified analysis of all materials proposed to be used under these specifications shall be submitted to the Engineer. If requested, samples shall be submitted for test and analysis. No material shall be used until it has been approved by the Engineer.

Pliability, ⅛ in. radius, 77°F	Pass
Porosity, in. of water at 200 fpm, avg., max	0.06
Ignition Loss, percent, max	2.1
Moisture Absorption, percent, max	1.0

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Along Roll	16.5
Across Roll	8.0
Trapezoidal Tear Strength, in.-lbs./in., avg., min.	
Along Roll	2.0
Across Roll	4.0
Pliability	
1 inch Mandrel at 0°F	Pass
½ inch Mandrel at 32°F	Pass
⅛ inch Mandrel at 77°F	Pass
Saturation—percent by weight of extractable material, min	65.0
Moisture Absorption, percent, max	0.5

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2.5 METHODS OF TESTING

Except as otherwise noted, methods of testing shall be the latest revision of methods adopted by the American Society for Testing Materials.

(a) *Asphalt Primer*

Bond Strength—See Appendix I, page 14
Flash Point—Method of Test approved by Bureau of Explosives, A.A.S.H.O. Method of Test T79
Viscosity—ASTM Method of Test D88
Distillation—ASTM Method of Test D402
Penetration—ASTM Method of Test D5
Softening Point—ASTM Method of Test D36
Solubility in Carbon Tetrachloride—ASTM Method of Test D4, except that CCl_4 is used instead of CS_2 as solvent, Method No. 1

(b) *Asphalt Coating*

Softening Point—ASTM Method of Test D36
Penetration—ASTM Method of Test D5
Flash Point—ASTM Method of Test D92
Loss on Heating at 325°F.—ASTM Method of Test D6
Ash—ASTM Method of Test D271
Settlement—See Appendix II, page 16
High Temperature Sag—See Appendix II, page 18
Cracking or Disbonding after 5 hrs. at −20°F.—See Appendix II, page 18
Deflection Test (Initial Heating)—See Appendix II, page 18
Deflection Test (After 2-hr. Heating)—See Appendix II, page 19
Impact at 77°F.—See Appendix II, page 20
Peel—See Appendix II, page 19
Flow Resistance—See Appendix II, page 21
Electrical Resistance—See Appendix II, page 22

(c) *Pipe Line Wrap*

Weight—ASTM Method of Test D146
Tensile Strength (Rag and Asbestos Felts)—ASTM Method of Test D146
Tensile Strength (Glass Mat or Outer Wrap)—ASTM Method of Test D146 Modified—See Appendix III, page 25
Pliability—ASTM Method of Test D146
Elmendorf Tear—ASTM Method of Test D689
Glass Mat Thickness—Modified ASTM Method of Test D146—See Appendix III, page 25

Porosity—Modified ASTM Method of Test D737—See Appendix III, page 25
Ignition Loss—ASTM Method of Test D579
Saturation—ASTM Method of Test D146
Moisture Absorption—See Appendix III, page 27

Section 3—CONSTRUCTION

3.1 PREPARATION OF SURFACES

All oil and grease on the surfaces of the metal shall be removed thoroughly by flushing and wiping, using a fresh petroleum solvent and clean rags. After cleaning, the pipe shall be protected from and maintained free of all oil, grease, and dirt from whatever source until the pipe has received its final coating. All metal surfaces shall be thoroughly cleaned by blasting, or, when permitted by the Engineer, by wire brushing or scraping. Surfaces that rust before a priming coat has been applied shall be re-prepared. Adequate air separators shall be used to remove effectively all oil and free moisture from the air supply to the blaster. Any pipe showing faults after preparation shall be set aside for reconditioning or rejection.

3.2 ASPHALT PRIMING

The use of asphalt primer that becomes fouled with foreign substances or has thickened by evaporation of the solvent will not be permitted.

The primer shall be applied uniformly to the clean, dry surface in a manner approved by the Engineer. Any bare spots or holidays shall be recoated with an additional application of the primer.

The Engineer may require the pipe to be reprimed if undue delay or surface contamination occurs between the application of the prime coat and the coating application. When the primer has dried to an extent acceptable to the Engineer, the first flood coat may be applied.

3.3 ASPHALT BASE PIPE LINE COATING APPLICATION

The coating shall be heated in kettles approved by the Engineer and equipped with accurate and easily read thermometers.

The coating shall not be overheated nor shall it be held in the kettle for an excessive period of time. Operating kettles shall be completely emptied at least once each day and cleaned, when necessary, before

Porosity—Modified ASTM Method of Test D737—See Appendix III, page 25
Ignition Loss—ASTM Method of Test D579
Saturation—ASTM Method of Test D146
Moisture Absorption—See Appendix III, page 27

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3.3 ASPHALT BASE PIPE LINE COATING APPLICATION

The coating shall be heated in kettles approved by the Engineer and equipped with accurate and easily read thermometers.

The coating shall not be overheated nor shall it be held in the kettle for an excessive period of time. Operating kettles shall be completely emptied at least once each day and cleaned, when necessary, before

another charge of unmelted coating is added; except, in the practice of field patching, the Engineer may permit continuous use of a heating kettle not exceeding 50-gallon capacity.

The coating shall be maintained moisture and dirt free at all times prior to and during the time of heating and application.

In loading the kettles the coating shall be broken into pieces not exceeding 20 lbs. each.

In heating the coating the charge shall be melted and brought up to application temperature without injury to the coating and in a manner approved by the Engineer. In a patching kettle, 50 gallons or smaller, the hot coating shall be thoroughly and continuously stirred with an iron paddle at intervals not exceeding 15 minutes.

3.4 APPLICATION OF WRAPPERS

The wrapping shall be applied in a uniform, snug-fitting spiral pattern, immediately following the application of the hot coating.

In the Single Wrap System the asphalt saturated felt or glass outer wrap shall remain on the outside surface of the coating. When a glass mat is used, it shall be completely embedded to provide a smooth surface of coating.

In the Single Coat—Double Wrap System the glass mat shall be applied first and completely embedded in the coating; immediately thereafter, the asphalt saturated felt or glass outer wrap shall be applied.

In the Double Coat—Double Wrap System the asphalt saturated felt or glass mat shall be applied to the coating; immediately thereafter the second coating shall be applied and the asphalt saturated felt or glass outer wrap immediately applied thereto.

3.5 WRAP

The overlap at the edges of the wrap shall be as specified by the Engineer. No wrinkling in the wrap shall be allowed and all end laps shall be cemented down with hot coating to secure a firm wrapping. All defective spots in the pipe coating shall be repaired to the satisfaction of the Engineer. All coating and wrapping operations shall be subject to the approval of the Engineer. Samples shall be cut from the coating, at the Engineer's discretion, for determination of thickness and bond of coating and wrap. After the coating and wrap have been applied, a test with an electric holiday detector shall be made and all coating defects shall be patched as directed by the Engineer.

3.6 ELECTRICAL INSPECTION

An electrical inspection of the completed coating shall be made by means of an approved electrical flaw detector and all defective areas shall be suitably patched.

3.7 HANDLING COATING MATERIALS AND COATED PIPE

All materials shall be transported and stored in such a manner as to prevent damage or contamination.

The coated pipe shall be handled in such a manner as to minimize damage. Wherever the coated pipe is supported, it shall be by means of s ings or skids approved by the Engineer. All bearing areas shall be inspected and damaged areas repaired.

Whenever the bottom of the ditch contains projecting rocks or hard objects which might puncture the protective coating, the bottom of the ditch shall be padded with a minimum of 6 inches of backfill material free of hard objects that might damage the coating.

The coated line shall be lowered in a manner satisfactory to the Engineer.

The ditch shall be backfilled around the pipe and to a depth of at least one pipe diameter above the top of the pipe, unless otherwise directed by the Engineer, with material free from hard or sharp objects which may damage the coating.

Backfilling shall be conducted at all times in a manner to prevent damage and abrasion to the exterior protection on the pipe.

3.8 SPECIAL OPERATIONS

Pipe sections, couplings or fittings shall be joined together and protected in a manner acceptable to the Engineer. However, one extra thickness of coating and wrap shall be required for all sections where the protection is manually applied.

3.9 SPECIAL PROVISIONS FOR SHOP-PROTECTED PIPE

Shop-coated pipe shall at all times be stored and transported in such a manner as to prevent damage to the coating.

The length of pipe to be left bare at ends shall be in accordance with instructions supplied by the Engineer. The exterior coating edges at ends of the pipe shall be scraped and feathered from the bare or primed surface to full thickness of the protective coating over a distance of not less than 1 inch.

Pipe shall be stored along the trenchside on wooden timbers placed under the uncoated ends of the pipe to hold the pipe off the ground.

3.10 EQUIPMENT

All equipment used in these operations shall be of a type satisfactory in all respects to the Engineer. No equipment shall be used which may cause undue damage to the pipe or protective system.

3.11 MISCELLANEOUS PROVISIONS

Where river weights, supporting or anchoring devices, or special coating materials are used, they shall be attached or applied in such a manner as not to damage the protective coating. The river weights shall be given a protective coating.

Mill-coated pipe shall have a reflective surface adequate to minimize softening due to sunlight.

Section 4—METHOD OF MEASUREMENT

4.1 The quantities to be paid for under these specifications shall be as provided in the contract.

Section 5—BASIS OF PAYMENT

5.1 The above quantities shall be paid for at the contract price and shall be in full compensation for all items included in the contract.

PART I
APPENDIX I
(Thin Coat Wrapped Systems)
ASPHALT PRIMER

I-1. TEST FOR BOND STRENGTH OF ASPHALT PIPE LINE PRIMERS FOR WRAPPED PIPE LINES

Scope

1. This method is intended to determine the strength of the bond between an asphalt primer and pipe line metal, when the test is made on a standard specimen under specified conditions of preparation and testing.

Apparatus

2. The apparatus shall consist of the following:

(a) Steel plungers—Two cylindrical steel plungers of one square inch cross sectional area, ±0.001 sq. in., and of sufficient length to be gripped firmly by the jaws of the testing machine. One end of each plunger shall be machined flat and its plane shall be at right angles to the axis of the plunger. It shall then be machine ground.

(b) Oven—The oven shall be of the convection ventilated type, capable of maintaining a temperature of 212°F. ± 1.8°F.

(c) Water Bath—A water bath maintained at 77°F. ± 0.18°F.

(d) Testing Machine—The testing machine shall be capable of maintaining a rate of loading of 50 ± 5 pounds per minute. It shall be provided with suitable jaws and universal joints so that the steel plungers bonded by the asphalt primer can be gripped tightly and held in alignment as the load is applied.

Preparation of Test Specimens

3. The machine-ground face of each of the two steel plungers shall be covered with the asphalt primer to be tested, the primer being flowed onto the surfaces with a brush. The primed surfaces shall be allowed to cure at room temperature for 24 hours and shall then be placed in the

oven, maintained at 212°F. ± 1.8°F., for 30 minutes. The plungers shall then be removed from the oven and the primed faces placed together and rotated slowly in opposite directions under a slight pressure in order to displace the air and obtain a proper seating. The bonded plungers shall then be cooled to room temperature and immersed in the water bath, maintained at 77°F. ± 0.18°F., for one hour.

Procedure

4. (a) The specimen shall be tested immediately upon removal from the water bath.

   (b) The steel plungers shall be so placed in the jaws of the testing machine that their long axes shall coincide with the direction of the applied pull through the center line of the grip assembly. The load shall be applied immediately at the rate of 50 ± 5 pounds per minute. The load shall be continued to failure. The bond strength of the asphalt primer shall be reported as the load necessary to cause failure, expressed in pounds per square inch.

PART I
APPENDIX II
(Thin Coat Wrapped Systems)
ASPHALT COATING

II-1. TEST FOR SETTLEMENT OF MINERAL FILLER IN FILLED ASPHALT PIPE LINE ENAMELS

Scope

1. This method is intended to measure the degree of settlement of mineral fillers from asphalt enamels containing finely divided mineral fillers for the coating of pipe lines.

Apparatus

2. (a) Glass Test Tube—The glass test tube shall be approximately 25 mm (1 inch) O.D. and 200 mm (8 inches) long.
   (b) Oven—The oven shall be capable of maintaining a temperature of 400°F. + 9°F.
   (c) Test Tube Holder—The test tube holder shall be capable of supporting one or more test tubes in a vertical position during the heating and subsequent cooling periods.

Procedure

3. A representative sample of the asphalt pipe line enamel shall be carefully heated to 400°F., stirring to avoid local overheating and to insure thorough mixing, and poured into the test tube to a depth of approximately 175 mm (7 inches). The test tube and contents shall be placed in the holder in the oven and maintained in a vertical position for 5 hours at 400°F. ± 9°F. The sample shall then be cooled for one hour at room temperature, after which the Ash Content shall be determined for the bottom half and for the top half. The Ash Content determination shall be conducted according to ASTM Method of Test D271. The Settlement of Mineral Filler shall be reported as the ratio of the Ash Content of the bottom half to the Ash Content of the top half.

II-2. METHODS OF TESTING ASPHALT PIPE LINE COATINGS FOR RESISTANCE TO HIGH TEMPERATURE SAG, CRACKING OR DISBONDING, DEFLECTION, PEEL, AND IMPACT

Scope

1. These methods are intended to determine the resistance of asphalt pipe line coatings to high temperature sag, cracking or disbonding, deflection, peel, and impact.

Preparation of Test Specimens

2. (a) Preparation of Test Plates—All tests shall be made on new mild steel plates that are flat and true to specified dimensions. One side of each plate shall be freshly sand-blasted to a uniform steel gray surface, completely removing stains, rust, mill scale, etc. For blasting, a sharp, dry sand having a minimum of 50% retained on a No. 60 sieve, or a No. 50 steel grit, shall be used, with an air pressure of not less than 50 pounds per square inch.

(b) Priming of Test Plates—All test plates shall be primed in accordance with the specifications for the material being tested.

(c) Preparation of Coating for Testing—Thirty (30) pounds of coating, broken into pieces approximately 4″ maximum dimensions, shall be rapidly melted over a large gas burner in a metal container of uniform cross-section and not less than 8″ nor more than 12″ in diameter. Immediately upon reaching the specified application temperature, the coating shall be thoroughly stirred and applied to the test plates required for High Temperature Sag Test, Cracking or Disbonding Test, Deflection Test (Initial Heating), Peel Test, and Impact Test. The remaining coating in the container, which shall be not less than 20 pounds, shall be maintained at the recommended application temperature for a 2-hour period. The coating shall be stirred with a metal bar at intervals of 15 minutes during the heating period. A ¼-inch steel plate shall be interposed between the container and the gas flame to avoid local overheating. After the 2-hour heating period, this coating shall be applied to the test plates required for Deflection Test (After 2 Hours Heating). The application temperatures and methods

of application shall be as recommended by the coating manufacturer.

(d) Application of Coating to Test Plates

Method A

The coating shall be applied to a thickness of from 2/32 to 3/32 inch over the entire surface of the test plates.

Method B

The coating shall be applied as directed under Method A, except that an uncoated border ½ inch wide shall be left around the coated surface of each test plate.

Examination of Applied Asphalt Pipe Line Coating

High Temperature Sag

3. Two test plates shall be prepared in accordance with either Method A or Method B. When prepared according to Method A, the plates shall be 12 x 4 x 3/16 in., and three parallel lines at 3-inch intervals from one edge shall be chalked or pencilled across the coated surface. When Method B is employed, the plates shall be 12 x 12 x 7/64 in., and lines 1 inch apart and parallel to one edge shall be chalked or pencilled on the coated surface and continued across the uncoated surface to the edges. The plates shall be placed in a vertical position, with the scribed lines horizontal, for 24 hours in an oven maintained at 160°F. ± 5°F. The plates shall then be removed from the oven, cooled to room temperature, and the average sag of the lines on the two plates shall be recorded as the sag of the coating expressed in inches.

Cracking or Disbonding

4. After the two plates, prepared by either Method A or Method B, have been used in the test for High Temperature Sag, they shall be placed for six hours in an air bath maintained at from −20°F. to −25°F. At the end of this period the plates shall be removed, allowed to reach room temperature, then examined for evidence of cracking or disbonding of the coating.

Deflection Test (Initial Heating)

5. Four plates, 10 x 4 x 1/16 inch, prepared according to Method A, shall be stored for six hours in an air bath maintained at a temperature of 40°F. ± 5°F.

Without removal from the air bath, the plates shall then be tested for resistance to disbonding by deflection using equipment installed for this purpose. Each plate in turn shall be placed on bearing blocks of ⅛-inch radius spaced on 9½-inch centers. The deflecting load shall be applied at a rate of 1 inch per minute to a ½-inch-radius mandrel placed across the plate midway between the bearing blocks, until cracking occurs as indicated by an electrical holiday detector. The deflection producing the initial cracking shall be measured and loading shall then be continued to a maximum deflection of 1½ inches. The specimen shall then be removed from the machine for examination. All disbonded coating shall be removed from the plate and the area of metal exposed shall be measured. The average results of initial cracking in inches and disbonded area in square inches for the four plates shall be recorded.

Deflection Test (After Two Hours Heating)

6. Four plates, 10 x 4 x 1/16 inch, prepared according to Method A, using the coating material that was held for two hours at the recommended application temperature, shall be used in this test. The procedure shall be the same as described previously under the Deflection Test (Initial Heating). The average results of initial cracking in inches and disbonded area in square inches for the four plates shall be recorded.

Peel Test

7. Two 12 x 12 x ½ inch plates, prepared in accordance with Method A, shall be allowed to cool to room temperature.

(a) Initial Bond—One test plate shall be tested immediately. The condition of bond shall be examined over a temperature range of 80°F. to 160°F. at successive intervals of 20°F., and with tolerances of the test temperatures of ±2°F. The test shall be made, at the temperature indicated, by immersing the plates for a period of approximately ½ hour in a water bath maintained at each of the specified temperatures. At the end of each of the immersion periods, the plate shall be removed from the bath and immediately tested for peel. This test shall be made as follows:

With a knife edge, cut two parallel lines through the coating approximately ¾ inch apart and approximately 4 inches in length. With the knife edge, cut under the coating strip at one end and loosen the coating from the plate the full width of the strip for about ½ inch. Place the knife blade under the loosened

end and with a firm grip apply a slow, steady pull upward on the strip of coating. For each specified test temperature at which the adhesion between the coating and the plate is sufficient to prevent peeling, stripping, or lifting, the result shall be recorded as "No Peeling."

(b) Bond, after 72 hours at 160°F.—The second test plate shall be stored for 72 hours in a horizontal position, with the coated side up, in an air bath maintained at 160°F. ± 5°F. At the end of this period, the plate shall be removed and cooled to room temperature. The coated plate shall then be tested for resistance to peel over a temperature range of 80°F. to 160°F., as for Peel Test, Initial Bond.

Impact Test

8. Two 12 x 12 x 7/64 inch plates, prepared in accordance with Method B, shall be brought to room temperature, after which they shall be immersed for at least one hour in a water bath maintained at a uniform temperature of 77°F. ± 2°F. Each plate shall be removed from the water bath, dried with a soft clean cloth and immediately subjected to the impact test.

(a) Direct Impact—Each plate shall be supported on a true plane surface of a block of wood. A 650-gram steel ball with a well-polished spherical surface shall be dropped from a height of 8 feet vertically above the surface of the coated plate. The ball shall be dropped to strike the coating at a point at least 4 inches from any edge of the plate. After one such impact, the coating shall be examined for evidence of shattering and loosening from the plate. Coating that has been knocked off the plate by the impact of the steel ball shall be considered as shattered coating. Loose coating is coating that has not been shattered but can be easily removed from the plate by fingers, or by the gentle use of a knife blade or similar instrument. The area of the plate from which the shattered and loosened coating can be removed shall be measured and recorded in square inches.

(b) Indirect Impact—After being subjected to direct impact, each plate shall be placed with the coated face down on a wooden block through which a 3½-inch diameter hole has been cut. The same steel ball shall be dropped from a height of 8 feet above the surface of the steel plate, so as to strike the plate at a point over the center of the hole in the wooden block. The point of impact shall

end and with a firm grip apply a slow, steady pull upward on the strip of coating. For each specified test temperature at which the adhesion between the coating and the plate is sufficient to prevent peeling, stripping, or lifting, the result shall be recorded as "No Peeling."

(b) Bond, after 72 hours at 160°F.—The second test plate shall be stored for 72 hours in a horizontal position, with the coated side up, in an air bath maintained at 160°F. ± 5°F. At the end of this period, the plate shall be removed and cooled to room temperature. The coated plate shall then be tested for resistance to peel over a temperature range of 80°F. to 160°F., as for Peel Test, Initial Bond.

Impact Test

8. Two 12 x 12 x 7/64 inch plates, prepared in accordance with Method B, shall be brought to room temperature, after which they shall be immersed for at least one hour in a water bath maintained at a uniform temperature of 77°F. ± 2°F. Each plate shall be removed from the water bath, dried with a soft clean cloth and immediately subjected to the impact test.

(a) Direct Impact—Each plate shall be supported on a true plane surface of a block of wood. A 650-gram steel ball with a well-polished spherical surface shall be dropped from a height of 8 feet vertically above the surface of the coated plate. The ball shall be dropped to strike the coating at a point at least 4 inches from any edge of the plate. After one such impact, the coating shall be examined for evidence of shattering and loosening from the plate. Coating that has been knocked off the plate by the impact of the steel ball shall be considered as shattered coating. Loose coating is coating that has not been shattered but can be easily removed from the plate by fingers, or by the gentle use of a knife blade or similar instrument. The area of the plate from which the shattered and loosened coating can be removed shall be measured and recorded in square inches.

(b) Indirect Impact—After being subjected to direct impact, each plate shall be placed with the coated face down on a wooden block through which a 3½-inch diameter hole has been cut. The same steel ball shall be dropped from a height of 8 feet above the surface of the steel plate, so as to strike the plate at a point over the center of the hole in the wooden block. The point of impact shall

be at least 4 inches from any edge of the plate and shall be at least 3 inches from the point of direct impact. After one such impact, the plate shall be examined for evidence of shattering and loosening of the coating. Coating that has been knocked off the plate by the impact of the steel ball shall be considered as shattered coating. Loose coating is coating that has not been shattered but can be easily removed from the plate by fingers or by the gentle use of a knife blade or similar instrument. The area of the plate from which the shattered and loosened coating can be removed shall be measured and recorded in square inches.

II-3. METHOD OF TEST FOR RESISTANCE OF ASPHALT PIPE LINE COATINGS TO FLOW UNDER SOIL STRESS

Scope

1. This method is intended to measure the resistance of asphalt pipe line coatings to flow under the conditions of temperature and load encountered by coatings on buried pipe lines.

Principle

2. The resistance to flow is determined by measuring the distance that a ¼-inch diameter, flat-ended, cylindrical brass rod, exerting a pressure of 2 pounds per square inch, penetrates a sample of the coating at a temperature of 85°F. ± 1°F. during a period of 100 hours.

Apparatus

3. The apparatus shall consist of the following:
   (a) Water Bath—A water bath capable of being maintained at temperatures of either 85°F. ± 1°F. or 115°F. ± 1°F.
   (b) Container—A shallow container, cylindrical in shape, and having a flat bottom, in which the specimen is tested. The inside depth of the container shall be somewhat greater than 0.125 inch and the inside diameter shall be greater than 2 inches.
   (c) Penetration Rod—A flat-ended cylindrical brass rod 0.250 ± 0.002 inch in diameter and weighing 0.100 ± 0.001 pound.
   (d) Depth Gage—A depth gage reading to 0.001 inch for measuring the penetration of the rod into the coating.

(e) Support—Any supporting apparatus that will allow the sample of coating to remain in a fixed horizontal position in the water bath, and the rod to penetrate vertically without appreciable friction, may be used. One part of the support should be suitable for attaching the depth gage which is used to determine the distance that the rod penetrates into the sample.

Preparation of Sample

4. The sample shall be melted at the lowest possible temperature and poured into the container to a depth of 0.125 ± 0.020 inch. The container and its contents shall be allowed to cool in air for one hour and shall then be placed on the support immersed in the water bath and maintained at a temperature of 85°F. ± 1°F. for one hour.

Procedure

5. With the sample still on its support in the water bath, the end of the penetration rod shall then be placed on the surface of the coating and its initial elevation reading shall be read from the depth gage. Care shall be taken that the rod is not placed on a bubble or surface irregularity. A final reading of the elevation of the rod shall be taken after 100 hours have elapsed. The difference between the two readings shall be recorded as Penetration in units of 0.001 inch, 100 hours, 85°F., 2 pounds per square inch. The average of at least three tests, whose values do not differ by more than 0.002 inch for penetrations less than 0.01 inch, or by more than 0.004 inch for penetrations greater than 0.01 inch, shall be recorded in inches. The resistance to flow at 115°F., 6 hours, 2 pounds per square inch, shall be determined in a similar manner.

II-4. METHOD FOR DETERMINING THE ELECTRICAL RESISTANCE OF ASPHALT PIPE LINE COATING

Scope

1. This method is intended to determine the electrical resistance of asphalt pipe line coatings when tested under standard conditions.

Preparation of Sample

2. The sample of coating shall be brought to the specified application temperature and immediately applied, at a uniform thickness of 1/16 inch,

(e) Support—Any supporting apparatus that will allow the sample of coating to remain in a fixed horizontal position in the water bath, and the rod to penetrate vertically without appreciable friction, may be used. One part of the support should be suitable for attaching the depth gage which is used to determine the distance that the rod penetrates into the sample.

Preparation of Sample

4. The sample shall be melted at the lowest possible temperature and poured into the container to a depth of 0.125 ± 0.020 inch. The container and its contents shall be allowed to cool in air for one hour and shall then be placed on the support immersed in the water bath and maintained at a temperature of 85°F. ± 1°F. for one hour.

Procedure

5. With the sample still on its support in the water bath, the end of the penetration rod shall then be placed on the surface of the coating and its initial elevation reading shall be read from the depth gage. Care shall be taken that the rod is not placed on a bubble or surface irregularity. A final reading of the elevation of the rod shall be taken after 100 hours have elapsed. The difference between the two readings shall be recorded as Penetration in units of 0.001 inch, 100 hours, 85°F., 2 pounds per square inch. The average of at least three tests, whose values do not differ by more than 0.002 inch for penetrations less than 0.01 inch, or by more than 0.004 inch for penetrations greater than 0.01 inch, shall be recorded in inches. The resistance to flow at 115°F., 6 hours, 2 pounds per square inch, shall be determined in a similar manner.

II-4. METHOD FOR DETERMINING THE ELECTRICAL RESISTANCE OF ASPHALT PIPE LINE COATING

Scope

1. This method is intended to determine the electrical resistance of asphalt pipe line coatings when tested under standard conditions.

Preparation of Sample

2. The sample of coating shall be brought to the specified application temperature and immediately applied, at a uniform thickness of 1/16 inch,

to the exterior of a capped ½-inch by a 6-inch steel nipple and to within 1 inch of the open end.

Procedure

3. Three inches of the coated section shall be immersed in a 1/10 normal sodium chloride solution for one week. At the end of this period, the electrical resistance of the pipe line coating to the passage of current between the sodium chloride solution and the metal nipple, when under a potential gradient not exceeding 6 volts, shall be measured by an ohmmeter having a minimum range of 10 megohms. The electrical resistance of the coating shall be recorded in megohms per square foot.

PART I
APPENDIX III
(Thin Coat Wrapped Systems)
PIPE LINE WRAPPING

III-1. METHODS OF SAMPLING AND TESTING WRAPPING MATERIALS FOR USE ON PIPE LINES

Scope

1. These methods cover the sampling and testing of asphalt saturated rag or asbestos felt and either unsaturated or asphalt saturated bonded fibrous glass mats intended for use as wrapping materials for the construction of asphalt protective coatings for pipe lines.

Sampling

2. From each shipment or fraction thereof, representing a product of the same kind, class, and weight, a number of rolls shall be selected at random equivalent to one half the cube root of the total number of rolls in the lot, except that in lots of 1,000 or less, five rolls shall be taken. If the cube root, as calculated, proves to be a fractional number, it shall be expressed as the next higher whole number. For convenience, the following table is given, showing the number of rolls to be selected from shipments of various sizes:

Packages in Shipment	*Number of Packages Selected*
Up to 1,000	5
1,001 to 1,728	6
1,729 to 2,744	7
2,745 to 4,096	8
4,097 to 5,832	9
5,833 to 8,000	10
8,001 to 10,648	11
10,649 to 13,842	12
13,843 to 17,576	13
17,577 to 21,952	14

Examination of Finished Wrapping Material

Tensile Strength

3. Test specimens shall be 3 x 22 inches. Ten test specimens shall be cut with the larger dimension along the roll and ten specimens shall be cut with the larger dimension across the roll. Both ends of each specimen of unsaturated glass wrap shall be impregnated for a distance of 2⅛ inches with a protective coating of shellac or methacrylate. Both sets of specimens shall be tested at 77°F., using a tension testing machine of the pendulum type of adequate capacity, and in which the clamps are attached to swivels free to move in any direction. The clamps shall be 1 x 3 inches and shall be covered with 1/16-inch thick soft rubber. The test specimen shall be gripped 2 inches from each end, leaving 18 inches between the clamps. The tension shall be increased by causing the lower clamp of the machine to travel at a uniform speed of 12 inches per minute. If any specimen breaks nearer than ½ inch to either clamp, the reading shall be disregarded, and an additional specimen shall be tested in its place. The ten readings along and across the roll, respectively, shall be averaged for each roll sampled. From these results the average strength along and across the roll, respectively, of the wrapping material as supplied shall be calculated.

Thickness

4. At ten equally spaced areas in each roll, selected by sampling, the thickness shall be measured with an Ames Dial reading to units of 0.0001 inch. A circular foot and anvil, both of one square inch area, exerting a pressure of 2 pounds per square inch, shall be used. All measurements shall be made in an atmosphere of 65 per cent relative humidity and at a temperature of 70°F. ± 2°F.

Porosity (Glass Mat Inner Wrap)

5. (a) Test Condition—Tests shall be made under standard atmospheric conditions at 70°F. ± 2°F. and a relative humidity of 65 ± 2 per cent.

(b) Test Specimens—Five test specimens, at least 10 x 10 inches, representative of the unsaturated glass mat to be tested, shall be provided, or tests may be made on the unsaturated glass fabric at five places as widely separated as possible without cutting.

(c) Apparatus—The apparatus shall consist essentially of a suction fan for drawing air through a known area of unsaturated glass mat; a circular orifice over which the mat to be tested can be clamped; a means for measuring the pressure drop across the unsaturated glass mat; and a means for measuring the volume of air flowing through the unsaturated glass mat. The clamp shall effectively eliminate edge leakage. The apparatus shall be capable of testing unsaturated glass mats of different thicknesses and of testing large pieces of unsaturated glass mat without cutting. The instrument shall be calibrated directly with a calibrated gasometer.

(d) Procedure—The test specimen of mat shall be mounted between the clamp and the circular orifice with sufficient tension to draw the unsaturated glass mat smooth. It shall not be distorted in its own plane. Conditioned air shall be drawn through the known area of the mat and through the calibrated flow meter at the rate of 200 cubic feet per minute and the pressure drop across the mat in inches of water recorded. The average of the test results for the five test specimens, or for the five different locations on the unsaturated glass mat, shall be reported as the porosity of the glass mat inner wrap expressed in inches of water.

Trapezoidal Tear

6. (a) Test Conditions—Tests shall be made under standard atmospheric conditions at 70°F. ± 2°F. and at a relative humidity of 65 ± 2 per cent.

(b) Test Specimens—Test specimens shall be 3 x 6 inches. Five specimens will be cut with the longer dimension along the roll, and five specimens will be cut with the longer dimension across the roll. An isosceles trapezoid, having an altitude of three inches and bases 1 and 4 inches in length, shall be marked on each specimen, preferably with the aid of a template. A cut ¼ inch to ⅜ inch in length shall then be made in the center of the 1-inch edge and perpendicular to it. Areas where a specimen is clamped shall first be impregnated with a protective coating of shellac or methacrylate.

(c) Testing Machine—A tensile testing machine, conforming to the requirements of the Standard Specifications for Textile Testing

Machines (A.S.T.M. Designation: D76) of A.S.T.M., shall be used. The faces of the clamps shall measure 1 by 3 inches or more, with the larger dimension perpendicular to the direction of application of the load. The distance between the clamps at the start of the test shall be 1 inch. If the machine is of the pendulum type, the pawls on the pendulum shall be disengaged from the ratchet.

(d) Procedure—The areas where the specimen is to be clamped shall be covered with masking tape. The specimen shall then be clamped in the machine along the non-parallel sides of the trapezoid, so that the cut is halfway between the clamps; the short edge shall be held taut, the long edge lying in folds. The machine shall be started and the average load necessary to tear the fabric shall be observed, preferably by means of an autographic recording device. The average of the results of the five individual tests on specimens cut along the roll shall be be reported as the tearing strength in pounds per inch along the roll, and the average of the results of the five individual tests on specimens cut across the roll shall be reported as the tearing strength in pounds per inch across the roll.

Moisture Absorption

7. (a) Test Specimens—Three specimens, approximately 6 x 6 inches each, shall be cut at random from each sample roll with a knife.

(b) Apparatus—Oven: The drying oven shall be capable of maintaining a temperature of 120°F. ± 5°F.

Humidity Cabinet: The humidity cabinet shall be capable of maintaining a temperature of 120°F. ± 5°F. and relative humidity of 95% ± 3%.

Can: The aluminum weighing can shall be fitted with a tight fitting lid and be of sufficient size to hold one specimen.

Balance: The balance shall be accurate to within 0.001 gram.

(c) Procedure—The three specimens shall be weighed individually, then placed on the drying oven at 120°F. until they have dried to a constant weight. They shall then be placed in the humidity cabinet for 24 hours at 120°F. and 95 per cent relative humidity. The aluminum can shall be weighed and one specimen removed from the humidity cabinet and placed immediately in the can. The conditioned weight of the specimen shall be determined by

weighing the can and specimen and subtracting the weight of the can from the total weight. The conditioned weight of the remaining two specimens shall be obtained in a similar manner.

(d) Calculations—Calculate the percentage of weight increase for each specimen due to moisture absorption as follows:

$$\text{Moisture Absorption, per cent by weight} = \frac{\text{Conditioned Weight} - \text{Dry Weight} \times 100}{\text{Dry Weight}}$$

The average of the determinations for the three specimens shall be reported as the Moisture Absorption in per cent by weight.

PART II

CONSTRUCTION SPECIFICATIONS

SPECIFICATION C-2

The Asphalt Institute — May, 1954

Specification

for

ASPHALT PROTECTIVE COATINGS FOR PIPE LINES
Thick Coat Wrapped Systems

Section 1—DESCRIPTION

1.1 Thick coat wrapped systems for pipe lines shall consist of a prime coat followed by one or more applications of asphalt coating in conjunction with one or more layers of reinforcing and protective wrappings. The initial layer of asphalt coating shall be not less than $\frac{3}{32}$ inch in thickness. Subsequent layers of asphalt coating shall be not less than $\frac{2}{32}$ inch in thickness; except, where an embedded reinforcing wrap is used, the additional layer of asphalt coating shall be not less than $\frac{3}{32}$ inch in thickness. When extra protection* is required, additional layers of asphalt coating and wrapping shall be applied. When rock fill is encountered, extra protection* consisting of selected backfill or prefabricated rock shields may also be employed.

1.2 The wrapping system shall be selected by the Engineer and shall conform to one of the types specified below:

(a) Where a single wrap is required, it shall be constructed according to the following system:

Single Wrap System

1 coat of Asphalt Primer
1 coat of Hot Asphalt Coating
1 wrap of Asphalt Saturated Felt or Glass Outer Wrap

* NOTE. The Engineer shall specify the location and extent of extra protection required.

(b) Where a double wrap is required, it shall be constructed according to one of the following systems:

Single Coat—Double Wrap System

1 coat of Primer
1 double coat of Hot Asphalt Coating
1 wrap of Glass Mat (embedded in coating)
1 wrap of Asphalt Saturated Felt or Glass Outer Wrap

Double Coat—Double Wrap System

1 coat of Primer
1 coat of Hot Asphalt Coating
1 wrap of Asphalt Saturated Felt or Glass Mat
1 coat of Hot Asphalt Coating
1 wrap of Asphalt Saturated Felt or Glass Outer Wrap

(c) Where more than a double wrap is required, the procedure specified in either of the Double Wrap Systems is modified to permit additional layers of Hot Asphalt Coating and inner wraps of Asphalt Saturated Felt or Glass Mat.

Section 2—MATERIALS

2.1 PRIMER

The primer shall be composed of a petroleum asphalt base and petroleum solvents, suitably blended to produce a liquid coating which may be applied cold by brushing or spraying and which will produce a suitable bond between the metal and the asphalt coating. The primer shall have good spraying, brushing and leveling properties and a minimum tendency to produce bubbles during application. It shall be homogeneous, free from water and shall meet the following requirements:

Bond Strength, 77°F., psi	250+
Flash Point (Open Tag), °F.	100+
Furol Viscosity at 77°F., sec.	50–150
Distillation:	
Distillate (percent of total distillate to 680°F.)	35+
To 374°F	75+
To 437°F	87+
To 500°F	97+
To 600°F	
Residue from distillation to 680°F., Volume percent by difference	30–45

Tests on Residue from Distillation:
Penetration at 77°F., 100 g., 5 sec..... 25–40
Softening Point (Ring & Ball), °F.....140–165
Percent Soluble in CCl_4..... 99.0+

2.2 Asphalt Coating

Either filled or unfilled asphalt coating may be selected for Thick Wrapped Systems at the option of the Engineer. The asphalt coating shall be composed of petroleum asphalt and, when filled asphalt is required, it shall be combined with appropriate inert mineral fillers. It shall be uniform in character, free from water and shall not foam when heated to 400°F. It shall meet the following requirements for the grade selected by the Engineer when tested in accordance with the methods hereinafter enumerated:

	Grade				
	I	II	III	IV	V
Softening Point (Ring & Ball), °F.....	185–205	215–230	235–250	185–200	200–230
Penetration at 77°F., 100 g., 5 sec.....	14–18	12–16	4–7	15–25	10–20
Penetration at 32°F., 200 g., 60 sec.....	8+	6+	2+	6+	5+
Penetration at 115°F., 50 g., 5 sec.....	35–	24–	11–	65–	55–
Flash Point (Cleveland Open Cup), °F.....	450+	450+	450+	450+	450+
Loss on Heating at 325°F., 5 hrs., %.....	0.5–	0.5–	0.5–	0.5–	0.5–
Penetration at 77°F. after heating, % of Original....	50+	50+	50+	60+	60+
Ash,%.....	10–40	10–40	10–40	1.0–	1.0–
Settlement (Ratio of ash in bottom half to ash in top half after 5 hrs. at 400°F.), Maximum.....	3:1	3:1	3:1	—	—
Electrical Resistance, Salt Water Immersion, 7 days, megohms/sq. ft....	1000+	1000+	1000+	1000+	1000+

2.3 PIPE LINE WRAPPING

The pipe line wrappings shall consist of asphalt saturated rag or asbestos felt and either unsaturated or asphalt saturated bonded fibrous glass mats. Choice of the wrappings will depend upon the Coating System selected by the Engineer.

(a) Asphalt Saturated Rag and Asbestos Pipe Wrapping Felts shall meet the requirements of ASTM D226 for the rag felts and ASTM D250 and ASTM D665 for the asbestos felt with the following modifications and additions. Roll widths, lengths and other packaging details shall be in accordance with agreements between the manufacturer and the purchaser. When used for an inner wrap, neither side of the felt shall be sanded or dusted with mica or any other material that will prevent an adequate bond. Where the felt is to be used for an outer wrap, the outer surface may be dusted. The pipe wrapping felts shall meet the following minimum requirements:

	13 lb. Rag Felt	20 lb. Rag Felt, Coated	15 lb. Asbestos Felt	23-½ lb. Asbestos Felt, Coated
Weight/100 sq. ft., min	12.8	20.2	13.6	22.5
Tensile Strength, lbs./lin. in., min.:				
Along Roll	50	50	25	30
Across Roll	20	20	10	15
Pliability at 77°F	Pass	Pass	Pass	Pass
Radius of Bend	½ in.	½ in.	1 in.	¾ in.
Elmendorf Tear, min.:				
Along Roll	200	200	140	140
Across Roll	300	300	160	160

(b) Glass Mat Inner Wrap shall be a thin, uniform, bonded mat, slit into suitable widths and packaged firmly and evenly on tubes as specified by the Engineer. The mat shall be free from large holes, thin spots, delaminations, tuftings, oil and grease, and relatively free from pimples, small holes, uncured binder spots, wrinkles, slugs, dust and torn edges. The ends of the rolls shall be clean,

smooth and square cut and shall show no telescoping. The glass mat inner wrap shall conform to the following requirements:

Weight/100 sq. ft., lbs., min	0.84
Thickness in inches, min	0.013
Trapezoidal tear strength, in.-lbs./in., avg., min.:	
Along roll	1.0
Across roll	2.0
Tensile Strength, lbs./lin. in., avg., min.:	
Along roll	9.0
Across roll	3.0
Pliability ⅛ in. radius, 77°F	Pass
Porosity, in. of water at 200 fpm, avg., max	0.06
Ignition Loss, percent, max	2.1
Moisture Absorption, percent, max	1.0

(c) Asphalt Saturated Glass Wrap shall be used for outer wrap only and shall have a smooth or veined appearance free from visible defects such as large holes, ragged or untrue edges, breaks, cracks, tears, protuberances or indentations. Loose mica or other material used for dusting shall be removed from the surface of the wrap by brushing or other suitable means prior to packaging. Roll widths, lengths and other packaging details shall be in accordance with agreements between the manufacturer and the purchaser. The asphalt saturant and surface material shall be applied uniformly in approximately equal thicknesses on both sides and up to the edges of the wrap. When unrolled at temperatures of 32°F. to 100°F., it shall not stick to such an extent as to cause tearing. The asphalt saturated glass outer wrap shall conform to the following requirements:

Weight/100 sq. ft., lbs., min	9.0
Thickness, in., min	0.030
Tensile Strength, lbs./lin. in., avg., min.:	
Along Roll	16.5
Across Roll	8.0
Trapezoidal Tear Strength, in.-lbs./in., avg., min.:	
Along Roll	2.0
Across Roll	4.0
Pliability:	
1 inch mandrel at 0°F	Pass
½ inch mandrel at 32°F	Pass

⅛ inch mandrel at 77°F	Pass
Saturation—percent by weight of extractable material, min.	65.0
Moisture Absorption, percent, max.	0.5

2.4 APPROVAL OF MATERIALS

Prior to use, a certified analysis of all materials proposed to be used under these specifications shall be submitted to the Engineer. If requested, samples shall be submitted for test and analysis. No material shall be used until it has been approved by the Engineer.

2.5 METHODS OF TESTING

Except as otherwise noted, methods of testing shall be the latest revision of methods adopted by the American Society for Testing Materials.

(a) *Asphalt Primer*

Bond Strength—See Appendix I, page 41
Flash Point—Method of Test approved by Bureau of Explosives, AASHO Method of Test T79
Viscosity—ASTM Method of Test D88
Distillation—ASTM Method of Test D402
Penetration—ASTM Method of Test D5
Softening Point—ASTM Method of Test D36
Solubility in Carbon Tetrachloride—ASTM Method of Test D4, except that CCl_4 is used instead of CS_2 as solvent, Method No. 1

(b) *Asphalt Coating*

Softening Point—ASTM Method of Test D36
Penetration—ASTM Method of Test D5
Flash Point—ASTM Method of Test D92
Loss on Heating at 325°F—ASTM Method of Test D6
Ash—ASTM Method of Test D271
Settlement—See Appendix II, page 43
Electrical Resistance—See Appendix II, page 44

(c) *Pipe Line Wrap*

Weight—ASTM Method of Test D146
Tensile Strength (Rag & Asbestos Felts)—ASTM Method of Test D146
Tensile Strength (Glass Mat or Outer Wrap)—ASTM Method of Test D146 Modified—See Appendix III, page 46
Pliability—ASTM Method of Test D146

Elmendorf Tear—ASTM Method of Test D689
Glass Mat Thickness—Modified ASTM Method of Test D146—See Appendix III, page 46
Porosity—Modified ASTM Method of Test D737—See Appendix III, page 46
Ignition Loss—ASTM Method of Test D579
Saturation—ASTM Method of Test D146
Moisture Absorption—See Appendix III, page 48

Section 3—CONSTRUCTION

3.1 PREPARATION OF SURFACES

All oil and grease on the surfaces of the metal shall be removed thoroughly by flushing and wiping using a fresh petroleum solvent and clean rags. After cleaning, the pipe shall be protected from and maintained free of all oil, grease, and dirt from whatever source until the pipe has received its final coating. All metal surfaces shall be thoroughly cleaned by blasting, or, when permitted by the Engineer, by wire brushing or scraping. Surfaces that rust before a priming coat has been applied shall be re-prepared. Adequate air separators shall be used to remove effectively all oil and free moisture from the air supply to the blaster. Any pipe showing faults after preparation shall be set aside for reconditioning or rejection.

3.2 ASPHALT PRIMING

The use of asphalt primer that becomes fouled with foreign substances or has thickened by evaporation of the solvent will not be permitted.

The primer shall be applied uniformly to the clean, dry surface in a manner approved by the Engineer. Any bare spots or holidays shall be recoated with an additional application of the primer.

The Engineer may require the pipe to be reprimed if undue delay or surface contamination occurs between the application of the prime coat and the coating application. When the primer has dried to an extent acceptable to the Engineer, the first flood coat may be applied.

3.3 ASPHALT BASE PIPE LINE COATING APPLICATION

The coating shall be heated in kettles approved by the Engineer and equipped with accurate and easily read thermometers.

The coating shall not be overheated nor shall it be held in the kettle

for an excessive period of time. Operating kettles shall be completely emptied at least once each day and cleaned, when necessary, before another charge of unmelted coating is added; except, in the practice of field patching, the Engineer may permit continuous use of a heating kettle not exceeding 50-gallon capacity.

The coating shall be maintained moisture and dirt free at all times prior to and during the time of heating and application.

In loading the kettles the coating shall be broken into pieces not exceeding 20 lbs. each.

In heating the coating the charge shall be melted and brought up to application temperature without injury to the coating and in a manner approved by the Engineer. In a patching kettle, 50 gallons or smaller, the hot coating shall be thoroughly and continuously stirred with an iron paddle at intervals not exceeding 15 minutes.

3.4 APPLICATION OF WRAPPERS

The wrapping shall be applied in a uniform, snug fitting spiral pattern, immediately following the application of the hot coating.

In the Single Wrap System the asphalt saturated felt or glass outer wrap shall remain on the outside surface of the coating.

In the Single Coat—Double Wrap System the glass mat shall be applied first and completely embedded in the coating; immediately thereafter, the asphalt saturated felt or glass outer wrap shall be applied.

In the Double Coat—Double Wrap System the asphalt saturated felt or glass mat shall be applied to the coating; immediately thereafter the second coating shall be applied and the asphalt saturated felt or glass outer wrap immediately applied thereto.

3.5 WRAP

The overlap at the edges of the wrap shall be as specified by the Engineer. No wrinkling in the wrap shall be allowed and all end laps shall be cemented down with hot coating to secure a firm wrapping. All defective spots in the pipe coating shall be repaired to the satisfaction of the Engineer. All coating and wrapping operations shall be subject to the approval of the Engineer. Samples shall be cut from the coating, at the Engineer's discretion, for determination of thickness and bond of coating and wrap. After the coating and wrap have been applied, a test with an electric holiday detector shall be made and all coating defects shall be patched as directed by the Engineer.

3.6 ELECTRICAL INSPECTION

An electrical inspection of the completed coating shall be made by means of an approved electrical flaw detector and all defective areas shall be suitably patched.

3.7 HANDLING COATING MATERIAL AND COATED PIPE

All materials shall be transported and stored in such a manner as to prevent damage or contamination.

The coated pipe shall be handled in such a manner as to minimize damage. Wherever the coated pipe is supported it shall be by means of slings or skids approved by the Engineer. All bearing areas shall be inspected and damaged areas repaired.

Whenever the bottom of the ditch contains projecting rocks or hard objects which might puncture the protective coating, the bottom of the ditch shall be padded with a minimum of six (6) inches of backfill material free of hard objects that might damage the coating.

The coated line shall be lowered in a manner satisfactory to the Engineer.

The ditch shall be backfilled around the pipe and to a depth of at least one pipe diameter above the top of the pipe, unless otherwise directed by the Engineer, with material free from hard or sharp objects which might damage the coating.

Backfilling shall be conducted at all times in a manner to prevent damage and abrasion to the exterior protection on the pipe.

3.8 SPECIAL OPERATIONS

Pipe sections, couplings or fittings shall be joined together and protected in a manner acceptable to the Engineer. However, one extra thickness of coating and wrap shall be required for all sections where the protection is manually applied.

3.9 SPECIAL PROVISIONS FOR SHOP-PROTECTED PIPE

Shop-coated pipe shall at all times be stored and transported in such a manner as to prevent damage to the coating.

The length of pipe to be left bare at ends shall be in accordance with instructions supplied by the Engineer. The exterior coating edges at ends of the pipe shall be scraped and feathered from the bare or primed surface to full thickness of the protective coating over a distance of not less than one (1) inch.